INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2015

Subject ST9 – Enterprise Risk Management

Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

F Layton
Chairman of the Board of Examiners
December 2015

A. General comments on the *aims of this subject and how it is marked*

1. The aim of the Enterprise Risk Management (ERM) Specialist Technical subject is to instil in successful candidates the key principles underlying the implementation and application of ERM within an organisation, including governance and process as well as quantitative methods of risk measurement and modelling. The student should gain the ability to apply the knowledge and understanding of ERM practices to any type of organisation.

2. The ST9 exam generally requires bullet point form or short form essay style answers that apply general principles to directly address specific circumstances. The answers given below are just one possible set of acceptable answers.

3. Candidates are awarded marks for all reasonable answers including different but still reasonable numerical solutions. Marks are awarded for working in the case of numerical answers.

4. Candidates' answers are made up of a series of points. For example, a point can be stating a valid type of risk, describing the type of risk or (part of) a calculation.

B. General comments on *student performance in this diet of the examination*

1. The paper was made up of one short question, two moderately short questions and two longer questions.

2. Question 1 covered issues around corporate governance; question 2 was a case study based on the Solvency II Own Risk and Solvency Assessment (ORSA); question 3 covered the generalised extreme value (GEV) distribution; question 4 was a case study based on solar power, feed-in tariffs and securitisation; and question 5 covered statutory solvency and the use of derivatives.

3. As is common practice, the large majority of the questions were:

   - based heavily on bookwork
   - based on simplified case studies; and/or
   - loosely based on actual and often relatively recent events.

4. The examiners seek to test the candidate's knowledge of the syllabus. The core reading is an important source for framing questions but not the only source. For this reason, candidates are encouraged to read the financial press and to consider how current news items can be applied to the issues and concepts contained in the core reading.

5. Well-prepared candidates scored acceptably well across the whole paper. The comments that follow the questions concentrate on areas where candidates could have improved their performance.

C. Comparative pass rates for the past 3 years for this diet of examination

Year	*%*
September 2015	48
April 2015	36
September 2014	39
April 2014	37
September 2013	35
April 2013	41

Reasons for any significant change in pass rates in current diet to those in the past:

Candidates marks were closely grouped, and showed less divergence than might have been expected, even within questions. The pass rate for this examination diet is not untypical. Variation in the pass rate between sessions is expected as different cohorts of students sit the examination.

Solutions

Q1

- To reduce operational risk.
- To protect the firm and its senior management and board members against employees breaking laws e.g. bribery, corruption, fraud, money-laundering. [Many countries now have bribery and corruption laws and fraud is usually a criminal offense.]
- In many cases senior management and the board will be responsible for employees breaking the laws, unless it can be proved that the firm had in place suitable training and record-keeping.
- These issues may already be handled in the compliance function.
- To reduce reputational risk / enhance reputation.
- Appropriate and clearly stated values that are adhered to will both protect and enhance the firm's reputation.
- The firm's values and ethics may already be included in the corporate governance systems to some extent.
- To improve future growth and profit potential.
- As the firm is an international consultancy it is likely to be well spread out both geographically and by type of individual, and this makes it more difficult to ensure that, as well as catering to local requirements, all employees understand and demonstrate the firm's values and ethics.
- The firm is likely to be trying to maximise profits and it is sometimes easy for employees to overlook values and ethics in pursuit of those profits.
- Values and ethics do not typically fall within ERM, corporate governance, internal audit and compliance functions.
- Unethical behaviour can easily result in a bad reputation and falling future growth and profits.

- To improve the quality of current and future employees.
- To encourage all employees to fully understand and behave in a way which is suited to the firm's values and ethics.
- This is unlikely to be included as a part of the regular training of employees elsewhere in the firm.
- To meet other pressures or expectations.
- A response to pressure from relevant professional bodies.
- To contribute towards demonstration of compliance with any Corporate Governance Code applicable in the relevant jurisdiction.
- A response to a scandal affecting the firm (or one of its competitors).
- A response to a similar appointment at a rival firm.
- A response to issues raised by an audit (internal or external) investigation.
- A response to comments by rating agencies
- Change in shareholder focus
- (Any distinct comments on internal drivers for change)

This question was reasonably well answered by most candidates, with nearly all scoring at least some marks.

Q2 (i)

- Solvency II is designed around 3 pillars covering:
  - Pillar 1: Quantitative requirements
  - Pillar 2: Qualitative requirements
  - Pillar 3: Disclosure
- The ORSA forms part of the Pillar 2 requirements of Solvency II.
- It requires each insurer to identify all the risks to which it is exposed…
- …to identify the risk management processes and controls in place…
- …and to quantify its ongoing ability to continue to meet its minimum and solvency capital requirements (MCR and SCR).
- (Note: explicit reference to MCR and SCR is not required)

(ii)

- Consistency across the group
- Ease of comparison between local subsidiaries
- Quicker than building bespoke version for each subsidiary…
- …and also cheaper
- Availability of group assistance for completing form
- May encourage collaboration between subsidiaries
- Transfer of knowledge → developing skills locally
- Clarifies what is expected by the group of each subsidiary in respect of the ORSA
- Improves quality of local supporting documentation
- Can help to improve risk management within each entity
- E.g. may prompt consideration of risks not already considered
- Or may highlight risk management/control or skill shortfalls, for which group expertise/assistance could be sought

- Helps consolidation to give a group wide view
- Thus identification of overlaps or of diversification potential…
- …and consequently may lower the capital allocation to a given subsidiary…
- … which would increase its return on capital.

(iii)

- Difficult to come up with a single form that will suit all subsidiaries…
- …and any resulting form may be so cumbersome/detailed that big picture is missed.
- Ensuring a similar standard for the inputs from the different subsidiary companies.
- Ensuring that each subsidiary has interpreted the requirements consistently.
- Different subsidiaries may have different risk taxonomies.
- Some risk exposures may be subjective or difficult to quantify.
- Ensuring that all subsidiaries meet their reporting deadlines/there may be delays.
- Communication between the group head office and each subsidiary may be challenging:
- entities may be in different time zones…
- … and speak different languages.
- The skill and experience levels may also vary significantly, which can exacerbate these problems.
- Potential reporting bias.
- There may be resistance if resentful about the extra work…
- …and the perceived loss of independence/control.
- Each subsidiary – particularly non-EU subsidiaries – may have different local regulations…
- …and/or internal reporting formats…
- …so the starting point for preparing these risk reports will not be the same as a result.
- Different subsidiaries may write very different types of business. Combining the risk reports into a single group report will be difficult.
- In particular, at group level the five largest exposures could be very different to those for individual entities.
- Different metrics used .
- Tick box culture/local differences.
- Difficulties combining different classes of business/different weights of different classes for different subsidiaries.
- Data protection and other regulations may make it difficult to share information on individual risks, particularly where this is non-public information.

(iv) For:

- Market specific.
- Can be a useful way for measuring the impact of a stress event / scenario on regulatory solvency and profits.
- Establishes a stress testing program that can be refined and improved later.
- Reduced set up time – no need to develop a new / group framework.
- Reduced costs – as above.
- Calculation basis is known – no need to carry out a project to educate staff.
- Results can be assessed against current KPIs and KRIs used in the group.

Against:

- Regulatory basis may not give a representative assessment of the subsidiary company or the group's risk.
- Some risks may be omitted, e.g. operational.
- Not consistent with the key point of the ORSA – i.e. Solvency II capital requirements.
- Pros/cons particularly important for emerging economies.
- Market may expect more than this.
- Different regulatory bases may make it difficult to consolidate results at group level.
- Particularly due to different calibration levels.
- May not identify concentrations of risk within the group…
- … for example, where one subsidiary reinsures risk to another subsidiary of International Insurance.

Part (i)	This bookwork question was generally well answered.
Part (ii)	Candidates generally scored well on this question.
Part (iii)	Candidates scored reasonably well on this question.
Part (iv)	Candidates scored moderately well on this question.

Q3 (i)

- Consider the maximum observations from each of a sample of independent, identically distributed random variables. As the size of the sample increases, the distribution of the maximum observation converges to the generalised extreme value (GEV) distribution.
- Parameters of the GEV include:
  - "location" (analogous to mean).
  - "scale" (analogous to standard deviation, so must be > 0).
  - "shape".
- Under the "standard" GEV distribution, location = 0 and scale = 1.
- The shape parameter determines the range of distributions to which the extreme values belong.
- It does this by giving a particular distribution that has the same shape as the tail of a number of other distributions.

- If "shape" > 0 (Frechet-type), the tail follows a power law.
- e.g. extreme values could have come from a student's t-, Pareto or Levy distribution.
- If "shape" = 0 (Gumbel-type), the tail is exponential.
- e.g. extreme values could have come from a normal or gamma distribution.
- If "shape" < 0 (Weibull-type), the tail has an upper limit.
- This is unlikely to be useful for modelling extreme risks.
- (Note: knowing that the GEV can have fat, exponential or a finite tail is more important than knowing the names of the three types)

(ii)

- The historical monthly investment return data must be divided into equally sized blocks.
- A decision on how much data is used (volume vs relevance) must be made.
- An "extreme value" is defined for this investigation as an investment return which is significantly negative.
- To model the probability of investment returns falling below –50%, the return period approach would most likely be used.
- The number of observations below the threshold (i.e. less than –50%) in each block is counted…
- …so the result of the analysis is the distribution of the rate of extreme observations per X (where X is the number of observations per block).
- The return level approach might also be used in order to understand the distribution of extreme values.
- Under this approach, the lowest (i.e. most extreme negative) observation in each block of data is chosen…
- …so the result of the analysis is the distribution of the lowest (most negative) observation per X.
- The GEV parameters are then fitted using maximum likelihood estimation techniques…
- …or method of moments (or similar).
- Repeat for each hedge fund.
- (Note: any mention of threshold exceedance suggests the use of the GPD rather than the GEV, so will not have gained credit).

(iii)

- GEV is for extreme values, and these values are extreme.
- The GEV approach assumes that the sample data is independent and identically distributed, and neither of these assumptions is likely to be reasonable.
- For example, a hedge fund might significantly alter its asset mix from month to month.
- Also, volatility tends to cluster…
- …and change over time.
- The data are monthly, so it would be very difficult to get a sufficient number of data points to parameterise a GEV distribution.
- This makes it even more difficult than normal to get the right balance in terms of the size and number of blocks.

- If the number of observations within each block is kept low, then there is less information under the return level approach.
- However, if the number of blocks used is instead kept low, then the variance of parameter estimates is high.
- To obtain more data, the analysis could go back as far historically as it can.
- However, the longer the historic time period, the increasingly less relevant the data is likely to be for modelling future (extreme) returns.
- For example, due to changes in the hedge fund strategies…
- …or even changes in the hedge fund managers…
- …or changes in the underlying economy.
- Data from funds with similar strategies could be aggregated into the analysis in order to increase the size of the data sample.
- But again, there is likely to be inherent heterogeneity between such funds and the team's own (i.e. not as relevant).
- Doesn't make used of all of the data.
- It could provide more information on the distribution of monthly returns below –50% rather than just the probability.
- The proposed approach does nothing to consider how the various funds (already held or being considered) might behave in a similar way in extreme circumstances…
- …i.e. tail correlations.
- Whilst hedge funds like to proclaim that they are independent, history suggests otherwise. The relationship of a single hedge fund's performance should always be considered in the context of other returns.
- Past not like future.

Part (i)	Whilst many candidates scored highly on this question, with a number scoring full marks, many also struggled with what was a relatively straightforward bookwork question. Some candidates confused the GEV distribution with the Generalised Pareto distribution.
Part (ii)	Fewer candidates scored very highly on this question, but there was still a wide range of marks for another bookwork-based question.
Part (iii)	Most candidates either scored very well or very poorly on this question.

Q4 (i)

- Main risk is credit/counterparty risk…
- …which can be mitigated by due diligence…
- …or possibly credit insurance/credit default swap.
- Credit risk exacerbated by long-term nature of loans .
- Power grid failure.

- There is a risk that revenues from unused electricity are lower than expected and do not adequately support payment of interest and capital on the loan.
- This could occur due to many reasons:
- The degradation of the solar panels may be higher than expected leading to less efficient energy generation.
- This risk can be mitigated by seeking expert input on expected and stressed degradation rates over time…
- …and negotiating the rate on the loan where necessary.
- There may be climate changes over time, or simply statistical variations, that result in less sunshine hours than envisaged over the term of the loan. For example, snow fall may cover the solar panels resulting in no energy generation for periods. This is most likely in winter.
- This risk can be mitigated by seeking expert input on the likely variation in weather patterns (and negotiating the loan terms where necessary).
- This can be mitigated by the use of weather derivatives (for the purpose of this question).
- Proportion of energy generated that is unused and sold to the power grid may be less than 50%.
- This risk can be mitigated by seeking expert input on anticipated power generation for the solar panels and average household energy usage (and negotiating the loan terms where necessary).
- The geographical location of the solar panels should be investigated to understand whether there is a concentration risk.
- In other words, whether all of the solar panels are installed on residential properties in one major city and its suburbs or whether they are more widely spread.
- Analysis of the loan should be tailored to reflect diversification of sunshine hours across the installed locations.
- The solar panels may be subject to storm damage.
- The risk can be mitigated by seeking expert input on the durability of the solar panels and their fixings (and negotiation of the loan terms where necessary)…
- … or insistence on insurance.
- The solar panels may be subject to vandalism.
- The mitigation actions are as for storm damage.
- Where insurance is undertaken there is a risk that these costs may increase, resulting in reduced free revenue streams (putting the loan repayments at risk).
- Likewise, the maintenance expenses may increase, reducing free revenue streams (and putting the loan repayments at risk).
- This risk can be mitigated by requiring maintenance to be covered by a long term outsourcing contract…
- …although there is then a secondary (counterparty) risk around the solvency of the outsourcer.
- Households may be tempted to tamper with the solar panels and/or smart meters.

- Ad-hoc checks/sampling should be required to mitigate the risk and reviews of the data completed to identify anomalous power generation data.
- There are legal risks associated with this transaction…
- … particularly since it is the first of its kind.
- SLAL's legal team will need to review the nature of the legal contracts that households have entered into as well as the SPV structure and proposed loan contract.
- External legal views may also be sought.
- The government is clearly actively considering how it could reshape the commitment, given the action already taken. So there is a risk of government back-tracking on the guarantee and reducing the subsidised rate paid for unused energy, even though this has already been attempted and blocked by the courts.
- Similarly, there may be challenges to the legality of the subsidy from customers who are unable to have solar panels fitted to their properties and who resent having to fund the subsidy through higher electricity bills.
- There is a related legal risk that the court blockage will be over-turned, e.g. under an appeal.
- The government may go even further and withdraw the scheme altogether.
- Or seek some other way of negating the benefits, such as not allowing the purchase of replacement parts to be tax deductible.
- However, such action would be contrary to the government's commitments to reduce carbon emissions.
- Mitigation – lobbying.
- Householders' energy companies may delay the payments for unused energy sold back to the power grid, thus creating a liquidity issue that may result in delays to the repayment of the loan.
- Worse still, the energy companies responsible for the payment of the subsidised rate for the energy may become insolvent, potentially leading to non-payment for the energy.
- The financial services regulator's view of the investment is not clear. The regulator may demand high capitalisation, reducing the attractiveness of the investment…
- … or rule that the investment is inadmissible.
- Meetings with the regulator to understand its views on this asset class would help.
- …although this may not be possible in the time available.
- While the return on the investment is high, so are the charges associated with the loan. Where external expert managers are sought, there is a risk that the charges could be much higher than expected.
- Investment in infrastructure assets is not within the current investment mandate and consequently SLAL has limited expertise. There are therefore related operational risks.
- As indicated above, this could be mitigated by getting external expert advice, although this would have a cost and would reduce the net return. In practice, deep expertise is not likely to be established within SLAL without investing in infrastructure assets over a long period of time.

- The ability to engage with external parties is limited due to the time barring of the decision to invest. This leads to a risk that the wrong decision is made due to a lack of information.
- However, stepping back from the investment at this stage may burn bridges, restricting SLAL's ability to invest in infrastructure assets in the future and losing its first mover advantage.
- The subsidised rate is based on the current standard rate which increases "in line with inflation". The bonds pay coupons at the rate of 4% above the yield on an index-linked bond. There may be basis risk if the two inflation measures used are not the same.
- It might be possible to use a derivative to match the inflation rates better…
- …but the measures should be correlated so the risk may not be deemed to be significant and so may be accepted rather than mitigated.
- There is a risk that the loan is not a good match for SLAL's liabilities.

[NB: This is covered in more detail in part (ii).]

- It may be necessary to adjust the rest of the asset portfolio in order to accommodate this loan, having undertaken a revised asset-liability matching assessment.
- Interest rate risk/inflation risk
- If SLAS's liabilities are largely nominal (rather than real) in nature then it may be felt necessary to partially hedge out the index-linked nature of the loan using suitable inflation derivatives.

(ii)

- The term assurance business may have a relatively short – say five year – average outstanding duration. The term of the loan is 25 years, leading to a duration mismatch.
- If SLAL invested in the loan to back its term assurance business then it would be exposed to the possibility of profits and losses arising due to the changes in the yield curve.
- The loan is also unlikely to have sufficient liquidity to make it suitable for backing the term assurance business, since assets may need to be liquidated at short notice to meet large individual claims or multiple claims arising from a catastrophe event.
- Therefore, the loan is not a suitable asset to back the term assurance business.
- The annuity business is likely to have a medium to long duration – say 10 to 12 years (average).
- Rather than targeting investments with the same duration, SLAL is likely to undertake cash-flow matching of the assets and liabilities.
- In Solvania the maximum term of government and corporate debt appears to be 15 years. Therefore, SLAL may struggle to obtain assets to match the longer duration annuity cash-flows.
- As the term of the loan is 25 years, SLAL may find this a useful addition to the portfolio of assets used to back annuity business…
- …leading to lower exposure to changes in the yield curve.

- Some of the annuities may be inflation linked. Where this is the case, the loan should provide a good match for these inflation linked liabilities, as the return on the loan is a real return.
- There are several underlying risks relating to the security of this asset, many of them unique to this asset class. This means they will diversify well with those risks already on SLAL's balance sheet.
- This, along with improved cash-flow matching as above, may mean the capital that needs to be held in respect of this investment is lower than would be the case for further government and corporate debt investment.
- Not a longevity or mortality hedge.
- Allow for the fact that a greater notional needs to be held to allow for possibility of lower than expected payments (i.e. credit haircut).
- SLAS's liabilities are likely to be largely written within its own country and hence there is no mismatching by currency.

(iii)

- The most significant risks are likely to be lower solar irradiation, higher solar panel degradation, failure of energy company and/or higher maintenance costs, change in government policy: any of these or any other reasonably material risk will have gained credit.
- For example:
- The level of solar irradiation should be stressed.
- Historic sunshine hour statistics should be collated for the locations where solar panels are installed as this will help explain the variation over time.
- For each year the insurer can estimate the energy that would be generated should the irradiation for that year be repeated.
- The insurer can then determine the total energy generated for that year across all the solar panels.
- A distribution can be fitted to the total energy generated and the consequential impact on the performance of the loan.
- The capital charge can then be assessed, typically utilising a VaR – say 99.5th percentile – or a TVaR approach.
- Expert opinion from meteorologists and climate change scientists will help to guide the insurer on what can be expected going forward relative to what has occurred in the past and any adjustments that might be necessary to the distribution and capital charge.
- The degradation of the solar panels should be stressed.
- Historic degradations statistics should be collated and then a similar process to that outlined above followed.
- Solar panel technology has advanced considerably over recent years. In addition, the placing of mass-produced solar panels on households' roofs has only recently been undertaken. Therefore, the data may be sparse and possibly not entirely relevant to the future so the data will need to be supplemented by expert opinion. Then follow the process as outlined above.
- More generally, marks should be given (under each method) for:
  - Collection of appropriate historic information: what.
  - Collection of appropriate historic information: from where.

- Projection of historic trends.
- Distribution fitting.
- Capital charge assessment, e.g. VaR or TVaR.
- Use of expert opinion in relation to sparse data.
- Use of expert opinion in relation to the projection of trends.

Part (i)	Many candidates scored reasonably well on this question, although the spread of marks was large. As always with this type of question, the key was to make as broad a range of points as possible. In particular, it was important to recognise the presence of both financial and non-financial risks.
Part (ii)	Whilst some candidates answered this question well, most struggled to make a sufficient number of points and justifications.
Part (iii)	This question was poorly answered, with few candidates scoring more than half marks. This was frequently due a lack of breadth in the answers.

Q5 (i) (a)

- The payoff at maturity for the buyer of a put option exercising that option is:

$$\max(E - X_T, 0)$$

where E is as defined in the question (exercise price) and X_T is the price of the underlying asset at the time of maturity T.

- Buying a put spread with "higher strike" and "lower strike" of E_H and E_L respectively is equivalent to buying a put option with an exercise price of E_H and selling a further put option with exercise price E_L.

- So the payoff at maturity for the buyer of a put spread exercising that option is:

$$\max(E_H - X_T, 0) - \max(E_L - X_T, 0)$$

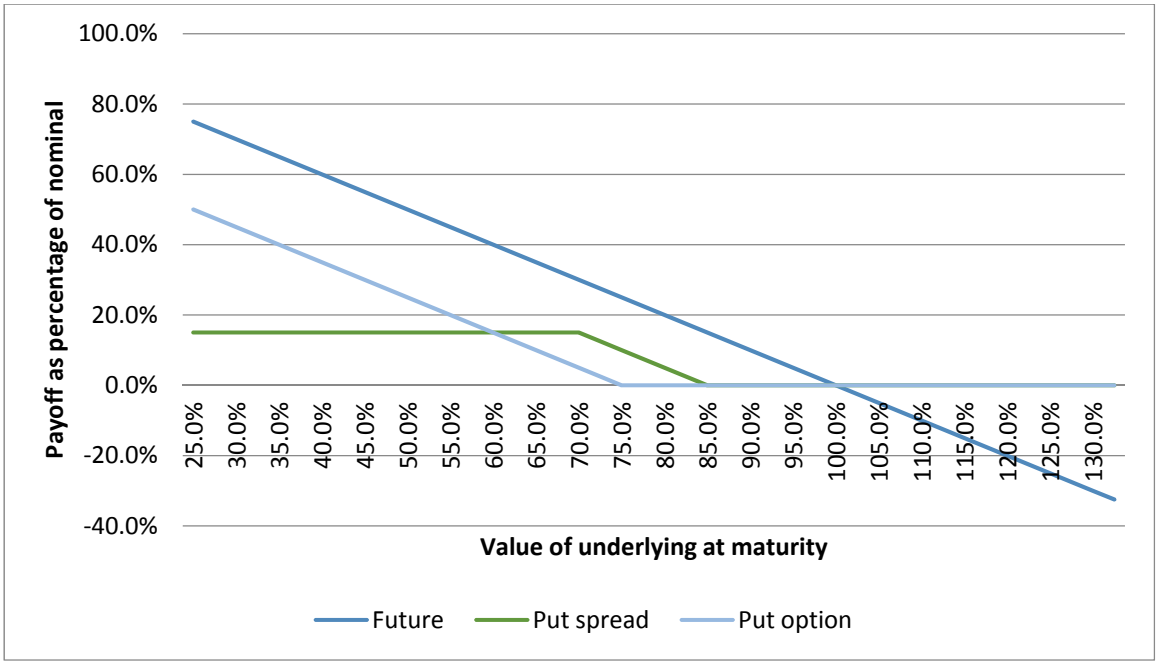
- Alternatively, give the above mark for any formulation in which:
  - If $X_T > E_H$ the result is 0;
  - If $E_H > X_T > E_L$ the result is $E_H - X_T$
  - If $E_L > X_T$, the result is $E_H - E_L$

- The payoff at maturity for the seller of a future is simply:

$$E - X_T$$

(b)

- These are illustrated below with example exercise prices.



(ii) **Futures**

- In theory, the Society's exposure to a fall in the value of the future AMCs could be hedged almost entirely using futures…
- …with the downside protection obtained by passing away all upside potential.
- Using a future involves no initial cost…
- …although margin collateral would need to be posted.
- This gives SARS certainty over the value associated with the AMCs, subject to persistency turning out as expected. If persistency is better or worse than anticipated then SARS may have under- or over-hedged the equity risk.
- Based on the description of Basis 2, the present value of future annual management charges is fully included on the balance sheet as this includes a best estimate valuation of the liabilities.
- If equity markets fall, the value of the future rises, offsetting the fall in the value of SARS' AMCs. The converse is also true…
- …so futures are the ideal solution for minimising SARS' required economic capital and stabilising the surplus economic capital under Basis 2.
- However, the hedge would be imperfect as the mix of equities in the funds under management is unlikely to mirror that underlying the benchmark indices that are referenced by the futures (i.e. basis risk).

- Indeed, the futures may not be available for several of the markets in which policyholders have invested, reducing the proportion of the equity risk that can be removed.
- Based on the description of Basis 1, the present value of future annual management charges is not fully included on the balance sheet.
- Therefore, rather than stabilising the surplus traditional capital (i.e. under Basis 1), purchasing futures may actually introduce additional volatility into the surplus capital on that basis.
- Further, it is not clear that an asset purchased to hedge an off balance sheet liability would be admissible, so the surplus capital on Basis 1 may be adversely impacted by the use of futures (or any sensible comment on admissibility).
- Worse still, the regulator may require SARS to reserve for reasonably foreseeable events such as a rise in equity prices. In this case there will be a further adverse impact on SARS' Basis 1 balance sheet immediately after the purchase of the futures.
- Where there is a rise in equity prices, there will be a fall in the value of the future. The future will be collateralised; the margin calls cannot be made utilising the increase in the value of the AMCs and must be made in the form of cash or other liquid assets from elsewhere, potentially leading to liquidity issues.
- Hence, whilst futures provide the best hedge from an economic perspective, the above issues lead to consideration of other possible hedges.

Put options/spreads

- With put options and put spreads, SARS would be purchasing downside protection…
- …and not passing away the upside potential.
- For this, SARS must pay a premium upfront.
- This is likely to be an expensive way to hedge the equity risk, particularly as SARS is not looking to hedge a one-sided guarantee.
- For equivalent exercise prices (i.e. considering the "higher strike" of the spread), the upfront premium will be higher for a put option than for a put spread, as protection is provided right the way down to a –100% return on equities whereas the protection afforded by the put spread will cease at the "lower strike".
- Therefore, of the two, a put spread is likely to be a more cost effective way of reducing the required economic capital and increasing the surplus economic capital under Basis 2.
- This is particularly the case if the "lower strike" is chosen to coincide with the size of the stress to equity prices.
- However, equity market movements below this level remain unprotected with a put spread.
- The impact on the surplus traditional capital under Basis 1 is less certain. Again, it is not clear that an asset purchased to hedge an off balance sheet liability would be admissible, so the surplus capital on Basis 1 may be reduced by the premium paid for the put option/spread.

- However, it is possible that the regulator could be persuaded to accept the inclusion of the value of the put option/spread on the balance sheet, in which case there would be no immediate impact on the surplus traditional capital under Basis 1.
- However, the use of put options/spreads does eliminate the need to reserve for a fall in equity prices…
- …and it removes the liquidity concerns.
- As for futures, the performance of the put option/spread is subject to persistency turning out as expected. If persistency is better or worse than anticipated then SARS may have under- or over-hedged the equity risk.
- As with the futures, basis risk remains.
- Indeed, there may be even fewer indices on which put options/spreads are traded, further reducing the proportion of the equity risk that can be removed.

Other comparisons

- Futures are exchange-traded and so should have greater price transparency and liquidity than puts and spreads, if the latter are only available "over-the-counter" from investment banks.
- Futures are simpler contracts than puts and spreads, requiring less expertise and being easier to explain to SARS' senior management.
- Exchange traded derivatives such as futures have lower counterparty risk than OTC derivatives such as (some) options.

(iii)

- Based on the answer to part (i), the value of the put spread can be determined as the difference between the value of a put option with a strike set to the "higher strike" for the put spread and the value of a put option with a strike set to the "lower strike" for the put spread.
- The value of the put options can be determined using the Black-Scholes (or Garmen-Kohlhagen) formula as follows:

$$P_t(E) = Ee^{-r(T-t)}\,\Phi(-d_2[E]) - X_t\,e^{-q(T-t)}\,\Phi(-d_1[E])$$

- where the notation used is as given in the question.

- We can therefore define the value of the put spread with "higher strike" and "lower strike" of E_H and E_L respectively at time t as $PS_t\,(E_H, E_L)$, where:

$$PS_t\,(E_H, E_L) = P_t(E_H) - P_t(E_L)$$

- which gives the required expression, after substitution of the appropriate Black-Scholes formula.

- A word-based answer can equally be given.

- For example, a put spread is simply a long put option with a higher strike less a short put option with a lower strike…
- …and these options can each be valued using the B-S model.

(iv) For the "higher strike"

$$P_0(850) = 850 \times e^{-0.5\%*(1.25-0)}\,\Phi(-d_2) - 1{,}000 \times e^{-3.8\%*(1.25-0)}\,\Phi(-d_1)$$

where:

$$d_1 = [\ln(1{,}000/850) + (0.5\% - 3.8\% + 19.8\%^2/2) \times (1.25 - 0)] / [19.8\%\sqrt{(1.25 - 0)}] = 0.65849$$

$$d_2 = [\ln(1{,}000/850) + (0.5\% - 3.8\% - 19.8\%^2/2) \times (1.25 - 0)] / [19.8\%\sqrt{(1.25 - 0)}] = 0.43712$$

implying:

$$P_0(850) = 850 \times e^{-0.5\%*(1.25-0)}\,\Phi(-0.43712) - 1{,}000 \times e^{-3.8\%*(1.25-0)}\,\Phi(-0.65849)$$

implying:

$$P_0(850) = 36.33$$

Similarly for the "lower strike":

$$P_0(700) = 700 \times e^{-0.5\%*(1.25-0)}\,\Phi(-1.02517) - 1000 \times e^{-3.8\%*(1.25-0)}\,\Phi(-1.29685) = 13.36$$

Therefore:

$$PS_0(850, 700) = P_0(850) - P_0(700) = 36.33 - 13.36 = 22.97$$

which is 2.3% of the €1,000m exposure.

(v)

- We are given that $PS_1(850, 700) = 11.4\% \times 1{,}000 = 114$
- The decrease in the required economic capital reflects the change in the value of the put spread over the year in which the stress has been applied, which is equal to €114m – €23m = €91m.
- The increase in the surplus economic capital is also €91m.
- This is because the available economic capital is unchanged, since a premium of €23m was paid for an asset with a market value of €23m.

(vi)

- Assuming the regulator can be persuaded that the put spread should be treated as admissible, there will be no impact on the surplus traditional capital, as a premium of €23m was paid for an asset with a market value of €23m.
- *Alternatively:*
- Assuming that the put spread is not admissible on this basis from a regulatory perspective, the surplus traditional capital is reduced by 97.5% of the premium i.e. by €22.4m.

(vii)

- From the information provided, the increase in the value of the put spread is:

  $PS_{0-1in5}(850, 700) - PS_0(850, 700) = 47 - 23 = 24$

- So the value of the put spread has increased by €24m.
- The available economic capital has therefore also increased by €24m, relative to the base scenario.
- But the value of the AMCs (and hence assets) has fallen by €120m (due to the 12% equity value fall).
- Thus the available economic capital also falls by €120m.
- The overall reduction in available capital is therefore €96m.
- The value of the put spread under the economic capital stress scenario has increased by €141m – €114m = €27m.
- Hence the required economic capital has reduced by €27m.
- This assumes that the required economic capital is otherwise unchanged; it is not possible from the information provided to assess the extent of any other changes to the stress scenario calculation due to the equity market movement.
- The change in the surplus economic capital in this scenario is therefore a decrease of €69m, which is the net impact of the decrease in the required economic capital of €27m and the decrease in the available economic capital of €96m.
- The overall impact of the put spread has therefore been an improvement of €51m, as the change in surplus capital would otherwise have been a decrease of €120m.

(viii)

- It gives an immediate surplus economic capital benefit…
- …and may not impact upon the surplus traditional capital adversely (depending on whether treated as admissible)/may have an adverse impact on basis 1.
- It also protects SARS against small shocks.
- The spread therefore appears to be attractive as a purchase.
- However, the benefit runs off and would need to be rolled over.
- Before recommending the purchase of this put spread, it would be useful to assess the cost of capital associated with the hedge.

- In addition, analysis allowing for the inefficiency of the hedge (or basis risk) would be useful.
- Confirmation with the regulator of the admissibility or otherwise of the spread under Basis 1 might also be useful.
- SARS may seek quotes for the same derivative from other investment banks.
- It may need to assess whether it has sufficient internal derivatives expertise to handle the transaction/monitor value of derivative/other related operational points.
- It may need information on how the counterparty risk with NBS will be managed e.g. use of collateral.
- Depends on shareholders' risk appetite.
- Look at cost/impact of other hedging options.

Part (i)	Whilst most candidates scored reasonably well on this question, a surprisingly large number struggled to draw the relatively simple payoff diagram.
Part (ii)	With a few exceptions, this question was poorly answered. Candidates typically failed to give broad enough answers that combined both advantages and disadvantages both on the basis of capital adequacy and on the basis of the general characteristics of futures and options.
Part (iii)	Whilst many candidates scored well on this question, some also scored no marks at all.
Part (iv)	This was a reasonably straightforward Black-Scholes question, and most candidates made a reasonable attempt, although few scored full marks.
Part (v)	This was a very poorly (and infrequently) answered question, with more than half of the candidates scoring no marks at all.
Part (vi)	Again, there were few attempts at this question.
Part (vii)	This was another poorly answered question with most candidates scoring no marks, and few getting anywhere near the maximum.
Part (viii)	More attempts were made at this question, but candidates still tended to score poorly. Again, reasonable marks could be scored by making points that related to a range of different areas, such as the financial benefit, admissibility, risk appetite and so on.

END OF EXAMINERS' REPORT